A Type Of Electro-Magnetic Frequency Bandwidth Compatible-Detecting Algorithm for Space Devices' Radiofrequency Equipment

一种航天器射频设备电磁频谱兼容性检测方法

Assistant Research Scientist
Harbin Institute of Technology
Feng A. An (fengan@iupui.edu)

Professor in Mechatronics Department
Harbin Institute of Technology
Hou Zhen Xiu (houzx5629@hit.edu.cn)

Abstract:

Nowadays, modern astronautics require highly advanced equipment and detecting devices. The Detecting Devices ordinarily do not require EMIC (ElectroMagnetic Interference Control) check before the whole body of the testing board can be fully developed.

However, we invent one kind of EMIC algorithm and implement this algorithm into a small rocket and then using a small 3-axis accelerator, we find out the EMIC parameters to be exactly what we are trying to acquire.

1. Introduction

In Modern Astronautics Devices and Space Shuttles, many source-powered and non-source-powered navigation devices are installed.

In the Overall Run, the whole system require overall smoothly in Electro-Interference part. However, since different devices all working at GHz-level and the transmitting radio-frequency are nearly the same. Many by-passes and collisions have occurred.

2. EMIC System Design Algorithm

The forecasting analysis Algorithm is highly advanced in the following three areas: No.1 Anti harmonic wave Interference; No.2 Anti combination wave Interference; No.3 Anti intermediation wave Interference.

To forecast the astronautics devices in Electro-Magnetic compatible features parts, main emphasis is focused on finding out how the device in itself can produce potentially additional and unexpected signals and then self-managed to transmit outside without any forms of antennas and RF PCB parts.

Another fear is the parasite capacitors around those main bus lines,

those capacitors are supposed to be able to produce very high speed oscillating RF signals and moment-powered unilateral streams of electroshock across the board wires.

We managed to collect those samples from the rocket's PCB board: base frequency bandwidth of the transmitter and the overall main base bandwidth frequency; oscillator start frequency of the transmitter; base RF signal's frequency bandwidth; operating frequency base bandwidth of the receiver and the upper/lower thresholding frequencies of the receiver.

In order to get the quality of the receiver's selected-band pass feature, the first VXO frequency of the receiver and overall main bandwidth frequency needs acquiring. And the same theory can also helps to maintain the receiver's first midband bandwidth frequency and the overall bandwidth value itself. For the transmitter side, we manage to use the idea to acquire the second VXO bandwidth frequency and overall main bandwidth frequency values. And the second midband frequency and its relevant bandwidth can be measured too.

Since the frequency convertors are not ideal multipliers, but a kind of non-linear devices. Using those devices, we only can manage to accomplish many sorts of multiplying. The cross modulation features of those devices are easily troubled by unexpected parasite channels.

For the first type: harmonic wave Interference. Based on the analysis about the base waves, we manage to analysis unforecasted harmonic wave features. Basically, those troubles in the components of the transmitter's harmonic waves.

For the second type: combination wave Interference. Since this type is mainly because two or more signals are mixed in non-linear components. New types of signals are produced, several or more frequency components are proved to be harmful to the overall astronautics system.

For the third type: intermediation wave Interference. The point is many outside signals are linearly combined with the transmitter's VXO signals in the mixer. Those new signal components combine in midband frequency and the overall signal is useless.

3. Implementing Details

The basic laws in implementing are in three stages: considering several major fractional degrees in the signals, aiming at anti intermodulation, anti signal mirroring, anti harmonic waves, and anti VXO/combined signals' troubling individually, first is to acquire parameters; build software models using Matlab; those models include interference source model and sensitive device models. Second, decide problem values precision level, decide number of troubled degrees in the software and types of troubled models.

For astronautics applications, commonly accepted law is to set the considered troubled degree numbers to 10.

The simulation model deletes useless interference pairs. For instance, interference sources and those sensitive devices all have interferences at the same frequencies. This can be achieved by comparing the time spots during the operating time.

One exception in the implementing process: the non-pole intermodulation. The non-pole intermodulation is one kind of signal distortion. While two or more frequency signals are in the same non-pole RF part, since the non-linear V-A relevance, multi-band frequency signals' mixing combination will produce cross modulation products: its frequencies are sum or difference of many kinds of harmonic waves.

Some Telecommunication Systems share one antenna for transmit and receive purpose. Since the non-pole RF parts' non linear features, useful band frequencies may also contain cross modulation products and those useless ones also enter the receive systems. This sign cause interference noises and lower the receiver sensitivity.

In common experiments, the considered interference noises' fraction precision degrees are 20.

4. Detailed Explanations about the Testing Results

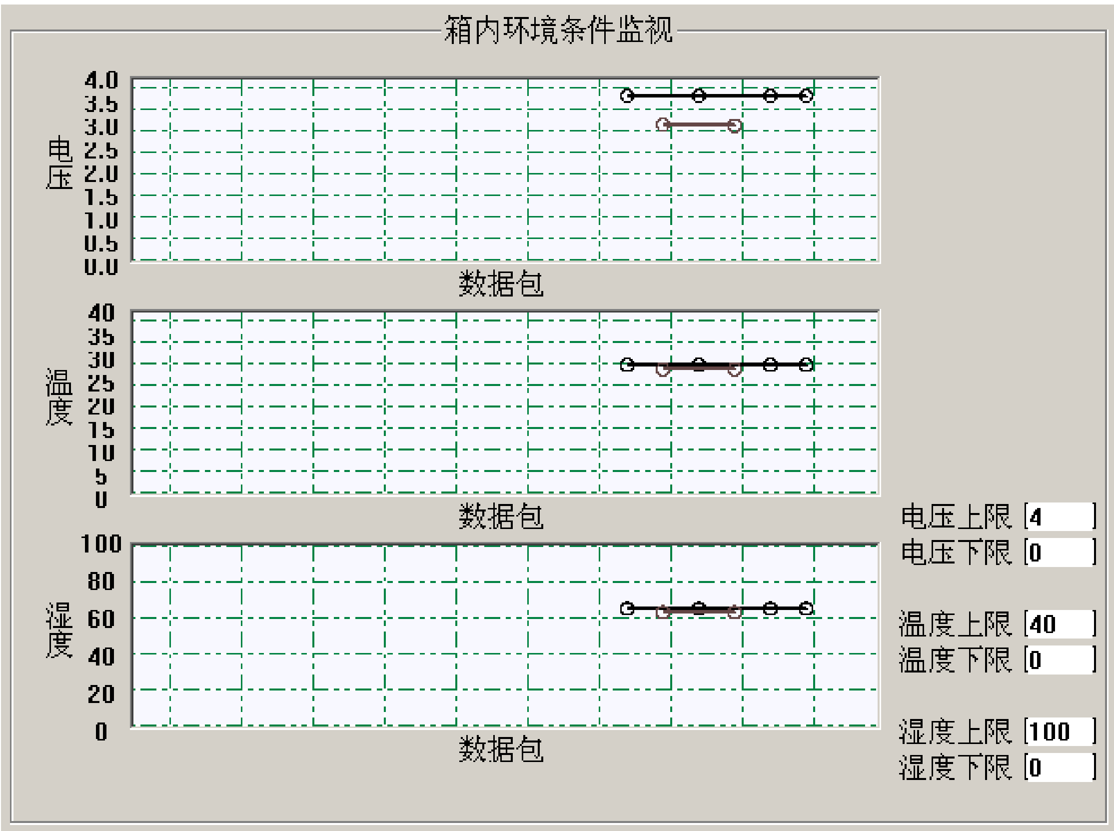
One instance is the analysis of two RF systems' inter-interference. We managed to divide the systems into interference sources and sensitive parts (the receivers). To set up empirical model, choose one interference source and one receiver, based on the input and output distortion features, since ordinarily natural noises can be decided by several specific designed Gaussian Random Variables and their simple sums and subtractions, we can

set up a formulation for the forecasting. For each type of interference, an individual equation can be drawn. We specify the fraction precision degrees of those equations to be linearly approaching the DEGREE 2. Using several pairs of interference samples, we can decide the empirical factor values in those equations.

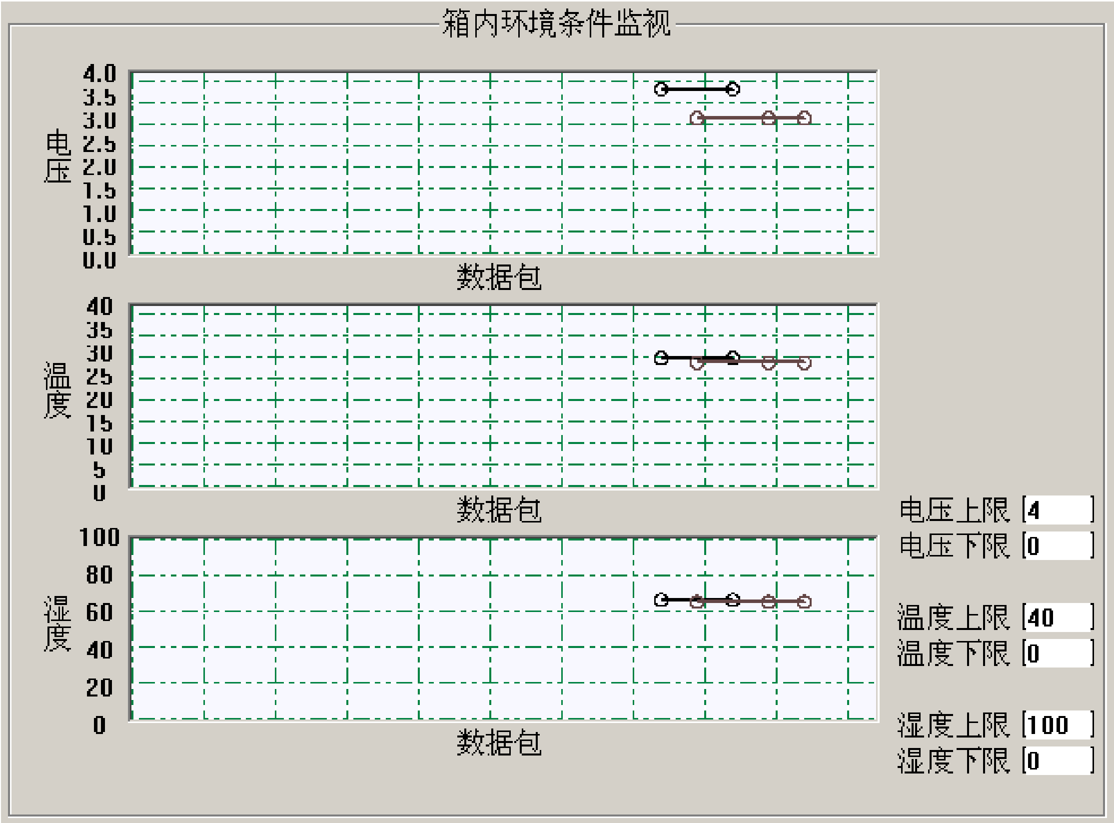
We then can decide the status of each type of interference sources by inventing a quality identifier M. This parameter shows the ponderance of the interference type in the overall system. The M value can be placed at the left side of those equations mentioned. In the final results, the higher the M value, the worse effects the interferences are causing.

5. Conclusion

For ordinary telecommunication systems, different antennas usually have different characteristics, in extreme cases, the telecommunication system’s input and output parts share the same antenna and the working modes are divided by time and by tasks specifically. In our experiments, we use Matlab to draw the diagram and charts and try to class the input and output antenna behaviors into two realms and show them on graph.



Graph 1. Consider Only Type 1 Interference



Graph 2. Consider Only Type 2 Interference

Graph 3. Consider Only Type 3 Interference

In total, if consider the three in total, the overall white noise environment in the astronautics devices themselves is extremely weak when the electric wires inside have high voltage transmitted. And the temperature and humidity measures should use uniform way to curve them down.

6. Biograph

Feng Anderson An (1987-), Assistant Research Scientist in Hongdu Aviation Group, Nanchang, China.
Hou Zhen Xiu, Professor in Department of Mechatronics, Harbin Institute of Technology. Harbin, China.